WE CLAIM:

1. A ball screw apparatus for an electric brake caliper, the ball screw apparatus comprising:

a cup-shaped ball screw having an annular cylindrical sidewall disposed about a rotational axis and closed at one axial end thereof by an end wall joined around an entire periphery thereof integrally with the sidewall, with the end wall adapted to form a carrier for operatively supporting at least one planetary gear; and

a ball screw nut operatively engaged with the ball screw.

2. The ball screw apparatus of claim 1 wherein the sidewall of the ball screw defines an axial length of the ball screw and a ball track extending about the sidewall along the axial length of the ball screw from starting point that is adjacent to but axially spaced from the closed end of the ball screw

3. The ball screw apparatus of claim 2 wherein the ball track includes a ball return track.

4. The ball screw apparatus of claim 3 wherein:

the ball screw nut is cup-shaped and includes an annular cylindrical sidewall disposed about a rotational axis and closed at one axial end thereof by an end wall joined around an entire periphery thereof integrally with the sidewall, with the side wall of the ball screw nut defining an inner surface of the ball screw nut sidewall having a ball track therein; and

the ball screw apparatus includes a plurality of balls residing concurrently in the ball tracks in the annular sidewalls of both the ball screw and the ball screw nut.

5. The ball screw apparatus of claim 4 further comprising a ring gear operatively engaged by the planet gear.

6. The ball screw apparatus of claim 4 wherein the ring gear is rotationally fixed relative to the rotational axis of the ball screw and extends into the ball screw inside of the annular cylindrical wall of the ball screw along the rotational axis of the ball screw.

7. The ball screw apparatus of claim 6 further comprising a thrust bearing operatively engaging the axial end of the ball screw opposite the closed end and adapted for reacting axial loads from the ball screw into a support structure.

8. The ball screw apparatus of claim 6 wherein:

the carrier formed by the end wall of the ball screw is a second stage carrier;

the ball screw apparatus includes at least one second stage planetary gear operatively supported by the second stage carrier;

the ring gear has a tubular shaped wall including an inner wall thereof defining internal gear teeth for engaging with the at least one second stage planet gear; and

the ball screw apparatus also includes a first stage carrier having a second stage sun gear fixedly attached thereto for engaging the at least one second stage planet gear, and operatively supporting at least one first stage planet gear operatively engaging the internal gear teeth of the ring gear; and

the ball screw apparatus further includes a first stage sun gear engaging the at least one first stage planet gear and adapted for connection to a drive motor.

9. The ball screw apparatus of claim 8 further including an electric drive motor drivingly connected to the first stage sun gear.

10. An electric caliper apparatus comprising:

a ball screw apparatus comprising a cup-shaped ball screw and a ball screw nut operatively engaged with the ball screw, the ball screw having an annular cylindrical sidewall disposed about a rotational axis and closed at one axial end thereof by an end wall joined around an entire periphery thereof integrally with the sidewall, with the end wall adapted to form a carrier for operatively supporting at least one planetary gear; and

an electric motor drivingly engaged with the carrier.

11. The electric caliper apparatus of claim 10 wherein the sidewall of the ball screw defines an axial length of the ball screw and a ball track extending about the sidewall along the axial length of the ball screw from starting point that is adjacent to but axially spaced from the closed end of the ball screw

12. The electric caliper apparatus of claim 11 wherein the ball track includes a ball return track.

13. The electric caliper apparatus of claim 12 wherein:

the ball screw nut is cup-shaped and includes an annular cylindrical sidewall disposed about a rotational axis and closed at one axial end thereof by an end wall joined around an entire periphery thereof integrally with the sidewall, with the side wall of the ball screw nut defining an inner surface of the ball screw nut sidewall having a ball track therein; and

the ball screw apparatus includes a plurality of balls residing concurrently in the ball tracks in the annular sidewalls of both the ball screw and the ball screw nut.

14. The electric caliper apparatus of claim 13 further including a ring gear for engaging the planet gear.

15. The electric caliper apparatus of claim 14 wherein the ring gear is rotationally fixed relative to the rotational axis of the ball screw and extends into the ball screw inside of the annular cylindrical wall of the ball screw along the rotational axis of the ball screw.

16. The electric caliper apparatus of claim 15 further comprising a thrust bearing operatively engaging the axial end of the ball screw opposite the closed and adapted for reacting axial loads from the ball screw into a support structure.

17. The electric caliper apparatus of claim 15 wherein:

the carrier formed by the end wall of the ball screw is a second stage carrier;

the ball screw apparatus includes at least one second stage planetary gear operatively supported by the second stage carrier;

the ring gear has a tubular shaped wall including an inner wall thereof defining internal gear teeth for engaging with the at least one second stage planet gear; and

the ball screw apparatus also includes a first stage carrier having a second stage sun gear fixedly attached thereto for engaging the at least one second stage planet gear, and operatively supporting at least one first stage planet gear operatively engaging the internal gear teeth of the ring gear; and

the ball screw apparatus further includes a first stage sun gear engaging the at least one first stage planet gear and adapted for operative connection to the electric motor.

18. An electric brake apparatus comprising:

an electric caliper having a brake pad adapted to frictionally engage a rotor;

a ball screw apparatus comprising a cup-shaped ball screw and a ball screw nut operatively engaged with the ball screw, the ball screw having an annular cylindrical sidewall disposed about a rotational axis and closed at one axial end thereof by an end wall joined around an entire periphery thereof integrally with the sidewall, with the end wall adapted to form a carrier for operatively supporting at least one planetary gear; and

an electric motor drivingly engaged with the ball screw apparatus and adapted to bias the ball screw nut into frictional engagement with the rotor.

19. The electric brake apparatus of claim 18 wherein:

the ball screw nut is cup-shaped and includes an annular cylindrical sidewall disposed about the rotational axis and closed at one axial end thereof by an end wall joined around an entire periphery thereof integrally with the sidewall, with the side wall of the ball screw nut defining an inner surface of the ball screw nut sidewall having a ball track therein; and

the ball screw apparatus includes a plurality of balls residing concurrently in the ball tracks in the annular sidewalls of both the ball screw and the ball screw nut.

20. The electric brake apparatus of claim 19 wherein:

the ball screw apparatus further comprises a ring gear operatively engaged by the planet gear and rotationally fixed relative to the rotational axis of the ball screw, extending into the ball screw inside of the annular cylindrical wall of the ball screw along the rotational axis of the ball screw;

the carrier formed by the end wall of the ball screw is a second stage carrier;

the ball screw apparatus includes at least one second stage planetary gear operatively supported by the second stage carrier;

the ring gear has a tubular shaped wall including an inner wall thereof defining internal gear teeth for engaging with the at least one second stage planet gear; and

the ball screw apparatus also includes a first stage carrier having a second stage sun gear fixedly attached thereto for engaging the at least one second stage planet gear, and operatively supporting at least one first stage planet gear operatively engaging the internal gear teeth of the ring gear; and

the ball screw apparatus further includes a first stage sun gear engaging the at least one first stage planet gear and adapted for operative connection to the electric motor to be driven thereby.